Acta Orthop Scand 1988;59(2):134–138

The calcar femorale as a landmark in hip physiolysis

Lars Ingvar Hansson[1]†, Gunnar Hägglund[2], Gunnar Ordeberg[2] and Staffan Sandström[3]

The position of the femoral head in relation to the calcar femorale was analyzed from 120 radiographs of normal hips. A constant relationship was found, providing a method of calculating the normal position of the femoral head. The method was tested in 56 cases with physiolysis of the hip and was found to be useful in determining the degree of slipping in both adolescents and adults.

The calcar femorale is a thin bone plate of constant appearance and location inside the proximal femur between the greater and lesser trochanter (Harty 1957, Griffin 1982). The structure can be visualized radiographically in children from 3 years of age (Harty 1957) and remains throughout life (Griffin 1982). The calcar femorale should not be confused with the medial cortex of the femoral neck.

We used the calcar femorale as an anatomic landmark to determine the degree of slipping in physiolysis of the hip (slipped capital femoral epiphysis).

Patients and materials

1. Normal material

Group A. Bilateral radiographs in anteroposterior and Lauenstein projections were obtained from 18 males and 22 females (aged 9–37 years) referred because of back pain or a knee disorder. None had a history of hip pain or hip disease. The growth plate or the scar from the growth plate and the calcar femorale were identified on the Lauenstein projection. The axis through the center of the femoral head perpendicular to the growth plate was drawn (Figure 1), and the distance between this axis and the calcar femorale was measured at different levels. Then, the mean distances were used to predict the position of the central axis from the calcar femorale. To test the internal validity, the difference between the axis constructed from the calcar femorale and the axis through the center of the femoral head was determined.

Group B. The external validity was tested in another radiographically normal sample of hips of 25 males and 25 females (aged 10–35 years). Only one hip from each patient was used. To be included, the calcar femorale had to be clearly defined, leaving hips of 20 males and 20 females suitable for analysis. The central axis was predicted from the calcar femorale using the mean values from group A and was compared with the central axis constructed from the femoral head.

2. Physiolysis of the hip

On radiographs from 56 consecutive children with physiolysis of the hip, the growth plate, the calcar

University Departments of Orthopedics in [1]Umeå and [2]Lund, and [3]Diagnostic Radiology, Lund, Sweden

Correspondence: Dr. Gunnar Hägglund, University Hospital Department of Orthopedics, S-221 85 Lund, Sweden

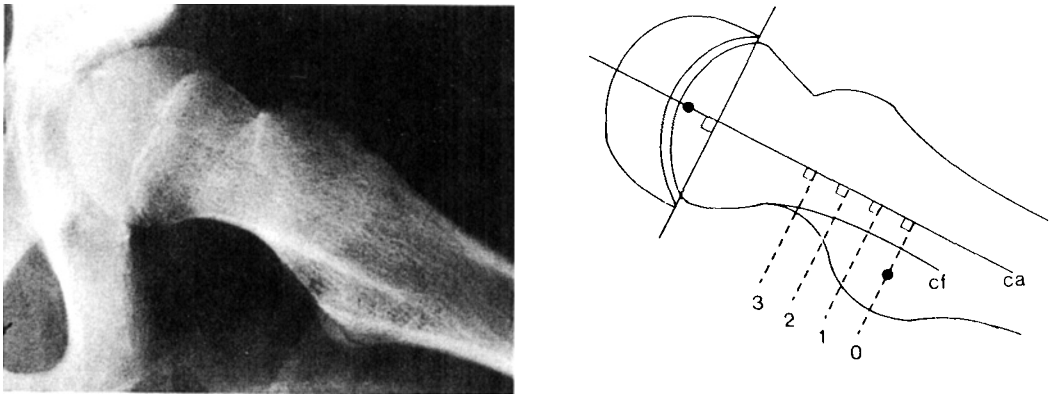


Figure 1. Relation between calcar femorale (cf) and central axis (ca) in a normal hip. Levels of measurements indicaed.

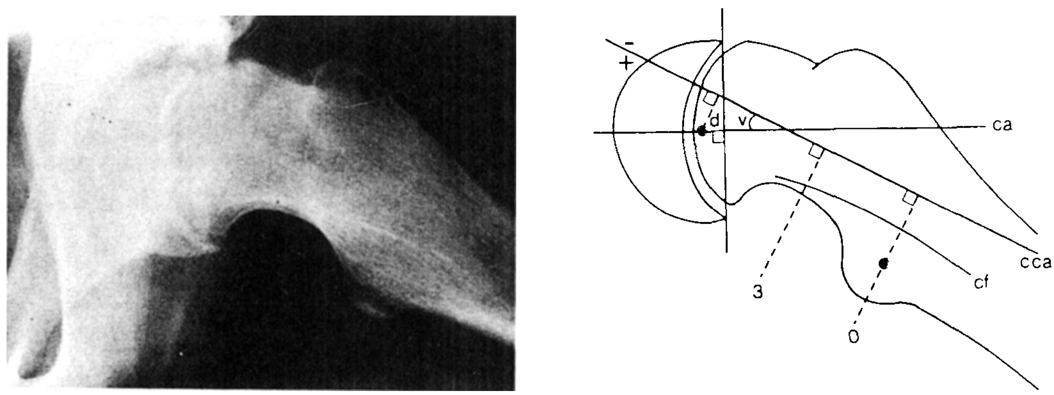


Figure 2. Calcar femorale (cf) calculated central axis (cca) in physiolysis of the hip. d=displacement of femoral head. v=angular deviation.

femorale, and the center of the femoral head were identified. As in the normal material, the calcar femorale was used to calculate the central axis, and the distance from this axis to the center of the femoral head was measured, as well as the angular deformity (Figure 2).

Of the 34 boys, 26 had unilateral and 8 bilateral slipping. The degree of slipping, according to Bianco (1966), in these 42 hips was mild in 34, moderate in six, and severe in two. In two slipped and three unslipped hips, the calcar femorale was not clearly defined.

All 22 females had unilateral slipping: 12 mild and 10 moderate according to Bianco (1966). The calcar femorale was not clearly defined in one slipped and two unslipped hips.

The statistical calculations were made using the Student's *t*-test.

Results

1. Normal material

In both sexes the calcar femorale was distinct from a level below the lesser trochanter and, in the proximal direction, to the area where the lamella joined the posterior cortex of the femoral neck. At the level of the lesser trochanter and 3 cm proximally, the calcar femorale was almost straight, parallel to the central axis and perpendicular to the growth plate. The angle of divergence between the calcar femorale and the central axis was 2.2 ± 4.1° in males and 1.2 ± 3.5° in females, both in the proximal direction. The distance between the calcar femorale and the central axis (Figure 1) at different levels is shown in Table 1. In girls aged 9–15 years, the distance was on an average 0.6 mm less than in the adults, and in boys aged 9–15 years 0.2 mm less

By using the mean distance from the calcar femorale at the level of the lesser trochanter and at the level 3 cm proximal to it, the central axis was predicted. The distance from this axis to the center of the femoral head (Table 2) gives the accuracy of the calculations in group A and the representativeness of the normal material in group B.

2. Physiolysis of the hip

Due to the displacement of the capital femoral epiphysis, the relationship between the calcar femorale and the femoral head is disturbed (Figure 2). Thus, the center of the femoral head is located below the central axis calculated from the calcar femorale. Displacement and angular deviation increased proportionally (r=0.89 in males and 0.92 in females) with the degree of slipping according to Bianco (1966) (Figures 3 and 4). A displacement of 1 mm corresponded to a deviation of about 2° in males and about 2.5° in females.

Four asymptomatic contralateral hips had radiographic evidence of mild slipping according to Bianco (1966). In the remaining contralateral hips judged as normal by conventional radiographic examination, the center of the femoral head was located 2.7 ± 3.9 mm below the central axis in the males ($P < 0.01$ compared with the original group) and 4.5 ± 3.5 mm below in the females ($P < 0.001$). The angular deviation was 3.5 ± 5.7° in the males ($P < 0.01$) and 8.2 ± 5.1° in the females ($P < 0.001$).

Table 1. Mean distance, *SD* (mm) between calcar femorale and central axis at different levels (according to Figure 1) determined in 36 male and 44 female hips

	Males		Females	
At level of lesser trochanter	11.1	*3.4*	10.0	*3.3*
1 cm	11.2	*3.1*	9.9	*3.0*
2 cm	11.4	*2.8*	10.1	*2.8*
3 cm	12.2	*2.4*	10.7	*2.4*
4 cm proximal	14.6	*3.7*	12.0	*2.4*

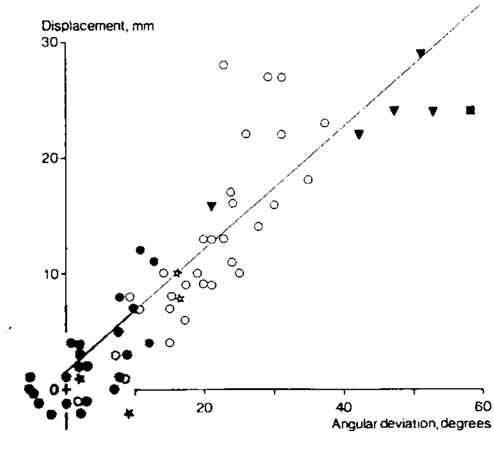


Figure 3. Displacement and angular deviation of femoral head in 34 boys with physiolysis of the hip (63 hips). Y=0.8+0.53X, r=0.89. Grey area indicates mean values+3 standard deviations in normal material.
● normal contralateral hip.
☆ asymptomatic slipping.
○ mild slipping (<1/3 of diameter of bony epiphysis).
▲ moderate slipping (1/3–2/3 of diameter).
■ severe slipping (>2/3 of diameter).

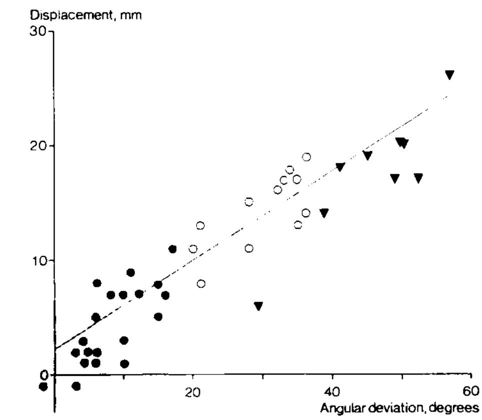


Figure 4. Displacement and angular deviation of femoral head in 22 girls with physiolysis of the hip (41 hips). Y=1.4+0.39X, r=0.92. Grey area and symbols as in Figure 3.

Table 2. Error of the radiographic method. Positive value means displacement/angulation below predicted central axis. Mean, *SD*

	Group A				Group B			
	Males		Females		Males		Females	
Displacement of caput center in mm (d)	0.2	*2.4*	0.0	*2.3*	−0.7	*2.0*	0.3	*1.9*
Angular deviation in degrees (v)	0.1	*3.5*	0.1	*3.3*	−1.9	*4.8*	−0.7	*3.6*

d and v according to Figure 2.

Discussion

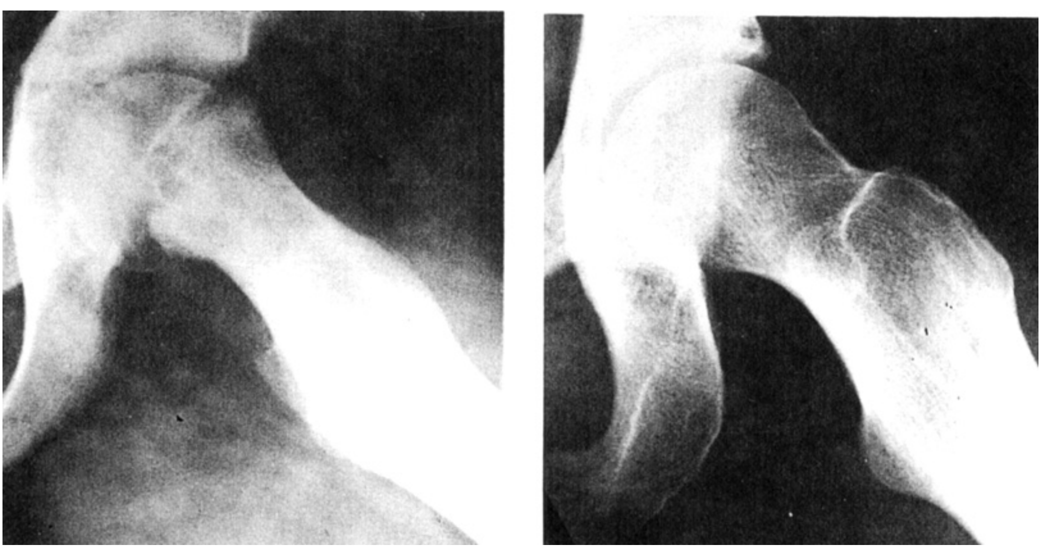
The constant relationship between the calcar femorale and the femoral head in normal hips provides a method of predicting the original position of the femoral head from the position of the calcar femorale. The calcar femorale must, however, be distinctly visualized. A Lauenstein projection is sufficient in most cases, but radiography in combination with fluoroscopy is sometimes needed. With a distinct calcar femorale, the method showed high accuracy and small variability in the normal material. From the optimal projection the calcar femorale becomes increasingly unsharp with internal or external rotation, and is after about 20° of rotation no longer visible. A projection of 20° from the optimal position gives a 6 percent shortening of the calcar distance (1−calcar distance × cosine 20°).

The Lauenstein projection is usually the best projection to demonstrate the displacement in physiolysis of the hip (Jerre 1950) and the calcar femorale. The direction of the slip is dorsal (Griffith 1976), most probably at a right angle to the calcar femorale.

The calcar femorale persists without evident change of position throughout life (Griffin 1982). Also after physiolysis of the hip, we have found an individually constant calcar femorale/femoral head relation when comparing radiographs from adolescence with radiographs more than 20 years after the slipping (Ordeberg 1986, Hägglund et al. 1987). Consequently, the method is suitable for evaluating the degree of slipping from radiographs in adults. This is demonstrated in Figure 5, showing a Lauenstein projection in a 44-year-old woman 32 years after physiolysis of the left hip without treatment. Her previous slip can hardly be detected unless the relation between calcar femorale and the femoral head is used.

Of the investigated children with physiolysis of the hip, five contralateral hips judged as normal with conventional examination showed inferior displacement of more than 3 standard deviations, indicating bilateral slipping. A high frequency of bilateral slipping has also been found with this method used at follow-up examinations (Ordeberg 1986, 58 percent; Hägglund et al. 1986, 67 percent), as with the method developed by Billing (1954); Billing and Severin (1959), 80 percent.

In physiolysis of the hip, early diagnosis is important for the long-term outcome. However, detection of mild slippings is not always easy (Griffith 1976); anteroposterior projections are not sufficient, and even Lauenstein projections



A B

Figure 5. A woman with untreated physiolysis. Lauenstein projection showing an almost normal configuration of the femoral head and neck, but a disturbed relation between the calcar femorale and the femoral head.
A. At the age of 12 years.
B. At the age of 44 years.

can be unsatisfactory. Our method is useful in diagnosis and is less complicated than the method described by Billing (1954). Moreover, the method allows the diagnosis and grading of physiolysis of the hip also after growth-plate closure.

However, some of our hips with mild slipping according to Bianco (1966) had a small displacement within 3 standard deviations using our method. It should be emphasized that in small slippings other signs – such as widening of the growth plate, periosteal reaction, or widening of the medial cortex of the femoral neck – must be used as signs of slipping. These very small slippings might be impossible to detect after growth-plate closure even with our method.

References

Bianco A J Jr. Treatment of slipping of the capital femoral epiphysis. Clin Orthop 1966;48:103–10.

Billing L. Roentgen examination of the proximal femur end in children and adolescents. Acta Radiol 1954; (Suppl 110).

Billing L, Severin S. Slipping epiphysis of the hip:A roentgenological and clinical study based on a new roentgen technique. Acta Radiol 1959;(Suppl 174).

Griffin J B. The calcar femorale redefined. Clin Orthop 1982;(164):211–4.

Griffith M J. Slipping of the capital femoral epiphysis. Ann R Coll Surg Engl 1976;58(1):34–42.

Harty M. The calcar femorale and the femoral neck. J Bone Joint Surg (Am) 1957;39:625–30.

Hägglund G, Hansson L I, Sandström S. Slipped capital femoral epiphysis in southern Sweden – long-term results after nailing/pinning. Clin Orthop 1987;217: 190–200.

Jerre T. A study in slipped capital femoral epiphysis. Acta Orthop Scand 1950;(Suppl 6).

Ordeberg G. Physiolysis of the hip. Epidemiology, natural history and long term results after closed treatment. Thesis, University of Lund, Lund, Sweden 1986.